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CURR HIST

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Tests
Chemistry 30
1966
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HIGH SCHOOL AND UNIVERSITY MATRICULATION

EXAMINATIONS BOARD

DEPARTMENTAL EXAMINATIONS, 1966

CHEMISTRY 30

Time — 3 hours.

DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION.
READ THE DIRECTIONS FOR EACH QUESTION CAREFULLY.

Total Possible Mark — 260.

All your work must be done in this booklet.
Do not write your name on this booklet.

Mathematical tables may be used.
Slide rules are permitted.

Page 2A contains the Periodic Table. This page, for convenience, should be torn along the perforation for ready reference when required.

Rough work and diagrams may be done in pencil.
Finished work must be done in ink (blue or black).

In solutions to problems enough work must be shown to indicate the method used. Give numerical answers to the NEAREST TENTH unless otherwise indicated.
Include units.

DO NOT FOLD THE BOOKLET.

Place your test booklet in the answer envelope in such a way that the **UPPER LEFT HAND CORNER OF THE BOOKLET** (Candidate's Number) shows through the **SLASHED CORNER** of the answer envelope.

BE SURE TO SEAL THE ENVELOPE.

USE THE ATOMIC WEIGHTS SHOWN IN THE PERIODIC TABLE.

Gas Constant, R = 0.0821 liters-atmospheres per degree-mole.

(For the use of Sub-Examiners only)

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URR HIST

Place the NUMBER corresponding to the best answer in the brackets to the right. Each correct answer has a value of 2 marks for questions numbered 1 to 25 inclusive.

1. Which of the following electron transitions would release the most energy?
(1) Fourth level to second
(2) First level to fourth
(3) Second level to first
(4) Third level to first (..........)

2. The oxidation number of oxygen in Na_2O_2 is
(1) –2
(2) –1
(3) +2
(4) +1 (..........)

3. A certain color of light has a wave length of 6300 Angstroms. This is the equivalent of
(1) 6.3×10^{-5} cm.
(2) 6.3×10^{-5} m.
(3) 0.0000063 cm.
(4) 0.000063 m. (..........)

4. The reaction of hydrogen bromide with ethylene is an example of a chemical reaction called
(1) polymerization
(2) substitution
(3) addition
(4) condensation (..........)

5. The scientist who succeeded in proving the existence of the proton is
(1) Chadwick
(2) Rutherford
(3) Millikan
(4) Thomson (..........)

FOR ROUGH WORK

(No marks given for work in this space)

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Page 2A

Tear this page out for ready reference when required.

PERIODIC TABLE

PERIOD	GROUP 1A	2A	← TRANSITION ELEMENTS → GROUP 3B	4B	5B	6B	7B	← 8B →			1B	2B	GROUP 3A	4A	5A	6A	7A	GROUP 0
1											1 H 1.0							2 He 4.0
2	3 Li 6.9	4 Be 9.0											5 B 10.8	6 C 12.0	7 N 14.0	8 O 16.0	9. F 19.0	10 Ne 20.2
3	11 Na 23.0	12 Mg 24.3											13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.5	18 Ar 39.9
4	19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
5	37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc ---	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	57-71 See La Series	72 Hf 178.5	73 Ta 181.0	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (210)	85 At ---	86 Rn (222)
7	87 Fr ---	88 Ra 226.0	89-103 See Ac Series															

La Series	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm ---	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
Ac Series	89 Ac (227)	90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np —	94 Pu —	95 Am —	96 Cm —	97 Bk —	98 Cf —	99 Es —	100 Fm —	101 Md —	102 No —	103 Lw —

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6. In a covalent solid the units which occupy lattice points are
(1) ions
(2) molecules
(3) crystals
(4) atoms (..........)

7. One mole of carbon dioxide, CO_2, contains
(1) 6.02×10^{23} atoms of Carbon
(2) 6.02×10^{23} atoms of Oxygen
(3) 18.1×10^{23} molecules of CO_2
(4) three gram-atoms of CO_2 (..........)

8. Diamond is harder than graphite because in diamond
(1) the van der Waal's forces between molecules are stronger
(2) there is a tetrahedral covalent bonding
(3) the planar covalent bonding between atoms is greater
(4) some of the electrons are shared by several atoms (..........)

9. Organic reactions are generally characterized by
(1) slow reaction velocities
(2) formation of zwitter ions
(3) complete disintegration of reacting molecules
(4) polymerization (..........)

10. The net charge on the kernel or core of the fluorine atom is
(1) $+9$
(2) -7
(3) $+7$
(4) -1 (..........)

11. Select the compound in which chlorine is assigned the oxidation number $(+5)$.
(1) $HClO$
(2) $HClO_2$
(3) $HClO_3$
(4) $HClO_4$ (..........)

FOR ROUGH WORK

(No marks given for work in this space)

12. The maximum number of electrons with a principal quantum number of 4 is
(1) 8
(2) 32
(3) 16
(4) 64
(..........)

13. A deep-red coloration imparted to a non-luminous bunsen flame indicates the presence of
(1) Sr^{++}
(2) Ca^{++}
(3) Ba^{++}
(4) Cu^{++}
(..........)

14. The polar nature of molecules is determined by its dielectric constant. The most Non-polar substance is the one whose dielectric constant is
(1) 1.00026
(2) 4.00
(3) 80
(4) 2.007
(..........)

15. Dipole-dipole attractions exist in solid
(1) CO_2
(2) H_2
(3) NH_3
(4) NaCl
(..........)

16. In the third energy level, the 3d subshell is directly above the
(1) 4s subshell
(2) 3p subshell
(3) 4d subshell
(4) 3s subshell
(..........)

17. The carbon-carbon bond in benzene is a
(1) double bond
(2) single bond
(3) resonance hybrid bond
(4) none of these
(..........)

18. One would expect a crystal of calcium oxide to be
(1) molecular
(2) metallic
(3) covalent
(4) ionic
(..........)

FOR ROUGH WORK

(No marks given for work in this space)

19. The molarity of a solution which contains 126 g. of HNO_3 in 500 ml. of solution is

(1) 1M
(2) 2M
(3) 3M
(4) 4M
(..................)

20. Water is a very weak electrolyte with only a few water molecules dissociating into ions. The most accurate dissociation of water is represented by the equation

(1) $H_2O \rightarrow H^+ + OH^-$
(2) $H_2O + H_2O \rightarrow H_3O^+ + OH^-$
(3) $H_2O \rightarrow 2H^+ + O^{--}$
(4) $2H_2O \rightarrow 2H_2(g) + O_2(g)$
(..................)

21. Peroxide-initiated polymerizations proceed by

(1) natural process synthesis
(2) free radical formation
(3) isomeric saponification
(4) hydrocarbon combustion
(..................)

22. Light of a characteristic energy is emitted by an atom when an electron

(1) is raised to a higher energy level
(2) moves in a certain energy level
(3) drops back to a lower energy level
(4) increases its velocity
(..................)

23. The molecular formula of a gas which has a simplest formula CH, and a molecular weight of 78 a.m.u. is

(1) CH
(2) C_2H_2
(3) C_3H_3
(4) C_6H_6
(..................)

24. When an aldehyde is oxidized, the product is

(1) an alcohol
(2) a ketone
(3) an acid
(4) an ester
(..................)

25. To designate a specific nucleus, it is convenient to use a symbol such as ${}_{14}X^{29}$. The number of neutrons in this nucleus is

(1) 14
(2) 15
(3) 29
(4) 43
(..................)

FOR ROUGH WORK

(No marks given for work in this space)

Values

6 **26.** An atom of element "X" has the configuration:
$1s^2, 2s^2, 2p^6, 3s^2, 3p^4$

(a) The valence of element "X" is ....

(b) The total number of "s" orbitals is ....

(c) The total number of "p" orbitals is ....

(d) The atomic number of element "X" is ....

(e) The number of "3p" orbitals with unpaired electrons is ....

(f) The formula of the compound formed when element "X" combines with element "Y" whose atomic number is 11, is ....

3 **27.** Atoms X, Y, and Z occur in Period 3, and have 2, 6, and 7 valence electrons respectively. Write the electronic formula for the compound most probably formed between Y and Z. Name the bond formed.

Diagram

Name of Bond

....

....

FOR ROUGH WORK

(No marks given for work in this space)

Do Not
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This Space

Values

10 **28.** Give the electron-dot formula (electronic formula) of each of the following atoms, ions or molecules:

Example: water H_2O

$$\begin{array}{l} \;\,\cdot\cdot \\ :O:H \\ \;\,\cdot\cdot \\ \;\,H \end{array}$$

(a) nitrogen atom

(b) nitrogen molecule

(c) magnesium atom

(d) sulfide ion

(e) resonant forms of sulfur dioxide

4 **29.** Explain the difference between the following pairs:

(a) Lattice energy and hydration energy

(b) Ionization potential and oxidation potential

[OVER]

Values

14 **30.** Complete each of the following statements by writing an appropriate answer in the space provided.

(a) 186,000 miles per second is correct to three significant digits and as a power of 10 should be written

(b) All electrons in an atom of barium are paired. Its magnetic effect can be described as

(c) In a chemical reaction 1.0 grams of sodium uses only 1.5 grams of chlorine, even though 5 grams of chlorine are available. This reaction illustrates the Law of

(d) A substance which acts both as an oxidizing agent and a reducing agent in the same reaction is said to undergo

(e) When light emitted from an incandescent solid is passed through an incandescent vapor, the type of spectrum produced is

(f) A chemical reaction which yields products whose total heat content is less than the total heat content of the reactants is termed

(g) What is the electron dot symbol of element "X" if its "Z" value is 13?

(h) The number of molecules in 190 grams of $SnCl_2$ is

(i) When isopropyl alcohol is oxidized in the presence of a copper catalyst, the product is called

(j) The number of subshells in any main shell is equal to the

(k) The shape of a molecule formed by covalent bonding of sp^3 orbitals is

(l) The number of electrons in the 3d orbital of a cobalt atom is

Do Not
Write In
This Space

Values

(m) The electrode at which reduction occurs is always called the ....

(n) When soap is dissolved in water, the hydrocarbon clusters formed in water are known as ....

[OVER]

Do Not
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This Spac

Values

5 **31.** The electronic configurations for the following neutral atoms are to be used in questions (a) to (d):

1. $1s^2, 2s^2, 2p^6, 3s^2$
2. $1s^2, 2s^2, 2p^6, 3s^1$
3. $1s^2, 2s^2, 2p^6$
4. $1s^2, 2s^2, 2p^5$
5. $1s^2, 2s^2, 2p^3$

Select the number (1, 2, 3, 4, 5) of the electronic configurations which is the best answer to the following questions:

(a) Which of the above electronic configurations would you expect to have the lowest ionization potential? (..................)

(b) Which of the above electronic configurations would you expect for an inert gas? (..................)

(c) List the five configurations in predicted order of increasing ionization potential (lowest first). (..)

(d) Which configuration should have the highest second ionization potential? (..................)

FOR ROUGH WORK

(No marks given for work in this space)

Do Not Write In This Space

Values

3 **22.** On the molecular level, describe the effect that a pressure increase has upon the equilibrium vapor pressure of a volatile liquid. Assume that the temperature remains constant.

7 **33.** Write the chemical name for each of these compounds in the space indicated.

(a) NaClO

(b) $K_4Fe(CN)_6$

(c) V_2O_5

(d) $K_2Cr_2O_7$

(e) PbO_2

(f) $KHC_8H_4O_4$

(g) $H_2N(CH_2)_6NH_2$

FOR ROUGH WORK

(No marks given for work in this space)

[OVER]

Values

10 **34.** Write a balanced chemical equation for each of the following:

(a) The production of sodium ethoxide from ethanol and sodium.

....

(b) The ionization of hydrogen chloride by water to produce hydronium ions.

....

(c) The overall cell reaction that occurs in discharge of a Daniell Cell with zinc anode and a copper cathode.

....

(d) Silver chloride precipitate is treated with ammonium hydroxide.

....

(e) Hydogen gas reacts with oxygen gas liberating 116 kilocalories of heat. (Write the heat of reaction as a term of the equation.)

....

FOR ROUGH WORK

(No marks given for work in this space)

Do Not
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This Space

Values

3 **35.** (a) Draw a labelled, cross-sectional diagram of an electrolytic cell which could be used to explain the electrolysis of MOLTEN NaCl.

3 (b) Write the two half-reaction equations and over-all reaction equation of the electrolysis of molten NaCl. Balance electron charges for each equation.

Anode reaction:

....

Cathode reaction:

....

Over-All reaction:

....

2 (c) In an electrolytic cell, oxidation always occurs at the

...., and reduction occurs at the

.... (Name the two electrodes)

FOR ROUGH WORK

(No marks given for work in this space)

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Values

15 **36.** Name the following compounds and write their structural formulas.

(a) $CH_2(CH)_2CH_2$ Name ....

Structural
Formula

(b) CH_3NH_2 Name ....

Structural
Formula

(c) $C_3H_7COOCH_3$ Name ....

Structural
Formula

(d) C_6H_5Cl Name ....

Structural
Formula

(e) $C_3H_5(OH)_3$ Name ....

Structural
Formula

Values

8 **37.** Balance each of the following equations by the use of oxidation numbers. Indicate clearly each step used.

(a) $K_2Cr_2O_7 + HCl \longrightarrow KCl + CrCl_3 + H_2O + Cl_2$

(b) $P + HNO_3 + H_2O \longrightarrow H_3PO_4 + NO$

FOR ROUGH WORK

(No marks given for work in this space)

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Values

4 **38.** "It is not easy to see the reason for attractive forces between non-polar molecules." Text (Sienko and Plane)

Account for the existence of these forces.

4 **39.** Discuss the different types of lattice defects and their general effect upon the properties of crystalline solids.

FOR ROUGH WORK

(No marks given for work in this space)

Values

10 **40.** For each item in COLUMN B select the best answer from COLUMN A and write its corresponding NUMBER in the brackets provided.

COLUMN A

(1) Crystal structure analyses

(2) Group O of the Periodic Table

(3) Obtained from the measurement of dipole moments

(4) Energy released when an electron is added to an isolated neutral atom

(5) Must be observed in writing oxidation-reduction equations

(6) Limits number of electrons per orbital to two electrons

(7) Has an important effect upon some properties of solids

(8) Constituent of proteins

(9) Called absorption spectra

(10) Avogadro's number of H^+ ions

(11) Smaller molecules are combined to improve the yield of gasoline from petroleum

(12) Explains the hardening of oils in the presence of a nickel catalyst

(13) Is the only effective method of producing the active metals

COLUMN B

(a) Lattice defects (..................)

(b) Scale of electronegativity (..................)

(c) Pauli Exclusion Principle (..................)

(d) Amino Acids (..................)

(e) Hydrogenation (..................)

(f) Electron affinity (..................)

(g) Gram-equivalent (..................)

(h) Catalytic Re-Forming (..................)

(i) X-Ray diffraction (..................)

(j) Conservation of electrons (..................)

Values

14 **41.** What are the contributions to atomic theory or atomic structure which the following experiments have made possible?

(a) The paths of alpha particles were observed after they had been fired at a thin gold leaf.

(b) When light from an incandescent vapor is passed through a spectroscope, the spectrum observed is a bright-line spectrum characteristic of the element being vaporized.

(c) In the mass spectrometer, positive ions are accelerated through a slit and bent in a circular path by a magnetic field.

(d) The rate of rise of a charged oil droplet is measured by observing it with a telescope.

(e) The deflection of cathode rays by electric and magnetic fields.

Values

(f) When electricity is passed through aqueous solutions of electrolytes, evidence of chemical change can be observed at the electrodes.

....

....

....

(g) A beam of neutral silver atoms was found to be split into two separate beams when it was passed between the poles of a specially designed magnet.

....

....

....

FOR ROUGH WORK

(No marks given for work in this space)

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Values

10 **42.** Define or explain each of the following terms. Use complete sentences.

(a) Isotopes

(b) Dipole moment

(c) Heisenberg's Uncertainty Principle

(d) Polymorphism

(e) Dynamic equilibrium

Values

12 **43.** Complete the table for each equation:

	Oxidizing Agent	Reducing Agent	Total Electrons Exchanged
$2Na + 2H_2O \longrightarrow 2NaOH + H_2(g)$			
$H_2SO_4 + 2KOH \longrightarrow K_2SO_4 + 2H_2O$			
$2Fe^{+++} + Sn^{++} \longrightarrow 2Fe^{++} + Sn^{++++}$			
$2S_2O_3^{--} + I_2 \longrightarrow 2I^- + S_4O_6$			

FOR ROUGH WORK

(No marks given for work in this space)

Values

2 **44.** How many moles of iron atoms are present in 1.73 grams of iron?

2 **45.** Calculate the weight of 6.02×10^{23} molecules of carbon monoxide.

3 **46.** How many gram-atoms of hydrogen are there in 170 grams of H_2S?

FOR ROUGH WORK

(No marks given for work in this space)

Values

4 **47.** Analysis of compound A produced 1.82 grams tungsten and 0.12 grams carbon. Analysis of compound B produced 3.70 grams of tungsten and 0.12 grams carbon.

(a) Show how the above facts illustrate the Law of Multiple Proportions.

(b) Determine the empirical or simple formula of compound A.

2 **48.** If exactly 100 ml. of a gas at 10° C. are heated to 20° C. (pressure and number of molecules remaining constant), the resulting volume of the gas will be which of the following:

(a) 50 ml.
(b) 1.0 l.
(c) 375 ml.
(d) 1.03 l.
(e) 104 ml. (..................)

FOR ROUGH WORK

(No marks given for work in this space)

Values

3 **49.** If the average velocity of oxygen molecules is 1000 m.p.h. at 0° C., what would be the average velocity of nitrogen molecules at 0° C.?

6 **50.** 3.0 grams of gas is present in 2.50 liters at 27° C. and 0.5 atmospheres pressure. What is the molecular weight of the gas?

FOR ROUGH WORK

(No marks given for work in this space)

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Values

3 **51.** What is the MOLALITY of a solution that contains 2 grams of sodium chloride in 100 grams of solution?

3 **52.** How much barium hydroxide, $Ba(OH)_2$, is needed to make one liter of 0.01 NORMAL solution?

FOR ROUGH WORK

(No marks given for work in this space)

[OVER]

Do Not
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Values

53. Given the following data:

$C\ (diamond) + O_2(g) \longrightarrow CO_2(g) - 94.50$ kcal.

$C\ (graphite) + O_2(g) \longrightarrow CO_2(g) - 94.05$ kcal.

3 (a) Calculate the heat of reaction for the manufacture of diamond from graphite. The equation below represents the net equation for the reaction:

$$C\ (graphite) \longrightarrow C\ (diamond)$$

1 (b) In the production of artificial diamonds is there need for a high energy requirement? Explain.

4 **54.** A gas measures 400 ml. at a temperature of 25° C. and under a pressure of 800 mm. To what temperature in °C. must the gas be cooled if its volume is to be reduced to 350 ml. at a pressure of 740 mm.?

FOR ROUGH WORK

(No marks given for work in this space)

Values

4 **55.** Hydrazine, N_2H_4, can be burned with oxygen to provide energy for rocket propulsion. The end products are nitrogen gas and water vapor. The energy released is 150 kcal. per mole of hydrazine burned. How much energy is released if 10 kilograms of hydrazine are burned?

5 **56.** When a lead storage battery operates, the reactions are:

Anode: $Pb + S0_4^{--} - 2e^- \longrightarrow PbSO_4$

Cathode: $PbO_2 + 4H^+ + SO_4^{--} + 2e^- \longrightarrow PbSO_4 + 2H_2O$

How much PbO_2 is used when a current of 100 amperes is supplied by a battery for a period of one hour?

FOR ROUGH WORK

(No marks given for work in this space)

Values

8 **57.** In one of your laboratory experiments, you performed a qualitative analysis on a number of salts. You prepared 0.1M solutions of Na_2SO_4, Na_2CO_3, NaCl, NaI and provided for duplicate samples of each in the eight test tubes required. To one set of solutions you added the reagent $Ba(NO_3)_2$ and to the other set you added $AgNO_3$.Record your results below by writing only the formula and color of the precipitates that were formed.

On the chart as well, write the formula of the reagent you added to each precipitate to confirm the presence of the anion being tested.

SALTS	REAGENT $Ba(NO_3)_2$	REAGENT $AgNO_3$	CONFIRMATORY TEST REAGENT
Na_2SO_4			
Na_2CO_3			
NaCl			
NaI			

3 **58.** In another experiment involving some organic reactions, the reactivity of three alcohols was investigated. Concentrated hydrochloric acid was added to 1 ml. of each of the alcohols: 1 – butanol, 2 – butanol, and 2 – methyl – 2 – propanol.

(a) These alcohols have the same chemical composition. What term is used to describe this characteristic?

....

(b) What was your general observation when concentrated HCl was added to each of the three alcohols?

....

(c) What did this indicate about the C–OH bond of each alcohol?

....

FOR ROUGH WORK

(No marks given for work in this space)

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Values

7 **59.** A student performed an experiment on the quantitative analysis of copper sulfate.

(a) What is the chemical formula of the blue copper sulfate used?

....

(b) State specifically the purpose of this experiment.

....

....

....

....

(c) What chemical was required to displace copper from its salt?

....

(d) How could one tell that all the copper had been removed from the solution?

....

(e) Following the displacement of copper from its salt 1M H_2SO_4 was added to the solution. What was the purpose of this procedure?

....

(f) The final product was dried and weighed. Such an analytical procedure is called "g.........." analysis.

....

Total = $\frac{\qquad\qquad}{2}$ =

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